§32. Aerosol Formation and Hydrogen Co-deposition by Colliding Ablation Plumes

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It is predicted that, along with pellet implosions in a high-repetition rate inertial IFE reactor, the interior of target chamber will repeatedly be exposed to intense pulses of 14MeV neutrons, X-rays, high-energy unburned DT-fuel and He ash particles, and pellet debris such as hydrocarbon ions with the total power deposition reaching of the order of 10J/cm^2/pulse,.

As a result, wall materials will be eroded by various thermal and physical processes, including evaporation, sputtering and ablation (the ejection of materials in the plasma state), etc. Some of the eroded materials may collide with each other perhaps in the center of symmetry region of target chamber to form aerosol, which can then scatter laser beams, affecting the subsequent implosions.

On the other hand, materials that are not associated with aerosol formation will be re-deposited elsewhere after travelling across the chamber, which extends the wall lifetime. However, it is also possible that tritium may continuously be incorporated into these re-deposits, leading to the radio safety problem. Despite their importance, the aerosol formation and tritium build-up issues have not yet been addressed in the IFE research community.

In our previous work [1,2], some of the fundamental aspects of aerosol formation by colliding ablation plumes were investigated, using the LEAF-CAP setup [1] in which targets are irradiated by 3ω–YAG laser at 10Hz, each 6ns long, at power densities up to ~30J/cm^2/pulse. The present work is intended to investigate more details of hydrogen co-deposition behavior. Employed as the target samples are carbon (isotropic graphite), lithium and lead.

Shown in Fig. 1 are visible spectra taken from colliding ablation plumes of carbon in a hydrogen atmosphere in the LEAF-CAP setup. Along with the Swan band, H_α is clearly seen in these spectra. Under these conditions, collided carbon deposits are collected for about an hour on a Pyrex substrate. Thermal desorption spectrometry (TDS) data taken for these deposits are shown in Fig. 2. Also shown for comparison are the TDS data from ablated carbon deposits in vacuum. It is indicated that hydrogen

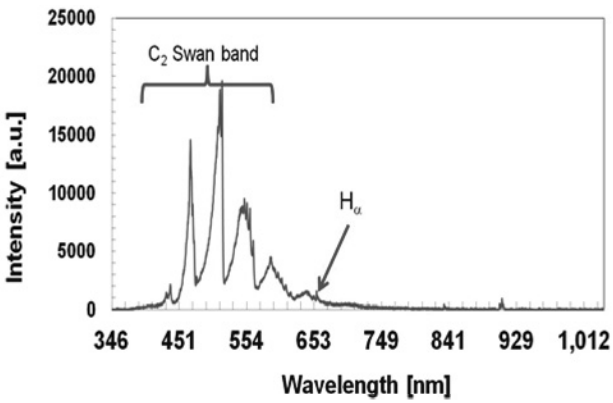

Fig. 1 Visible spectra taken from colliding ablation plumes of carbon in a hydrogen atmosphere [2].

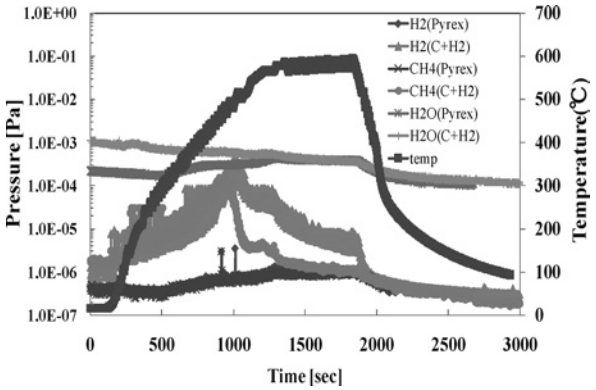

Fig. 2 TDS data taken from C-H co-deposits.

is thermally desorbed as H_2 and also as CH_4. However, we do not consider H_2O to be part of hydrogen desorption but due to the unbakeable parts used for TDS.

Hydrogen co-deposition experiments have been done for colliding ablation plumes of lithium and lead. Shown in Fig. 3 are the data taken from lithium-hydrogen deposits. Interestingly, all partial pressures start increasing at around the melting temperature of LiOH (462^{o}C) and peak at around ~550^{o}C. Hydrogen contents in these deposits are summarized in Fig. 4 where hydrogen co-deposition at 50Pa seen to result in the (H/Li) and (H/C) ratios ~0.25.

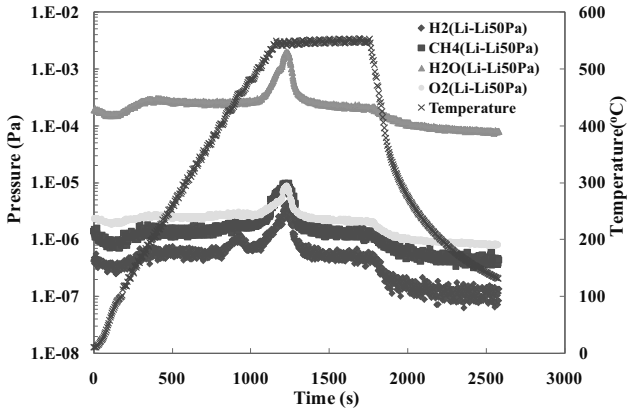

Fig. 3. TDS data taken from Li-H co-deposts [3].

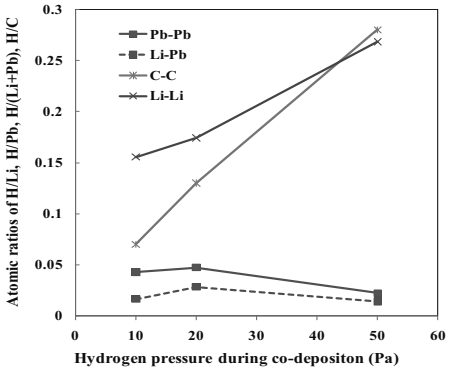

Fig. 4 Hydrogen co-deposition data for C, Li and Pb [3].

1) Hirooka, Y. et al. J. Phys. Conf. Ser. **244**(2010)032033.
2) Hirooka, Y. et al. Fusion Sci. Technol. **60**(2011)804.
3) Hirooka, Y. et al. Fusion Eng. Des. (To be published).